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EXERCISE ENVIRONMENT, SELF-EFFICACY, AND AFFECTIVE RESPONSES TO ACUTE EXERCISE IN OLDER ADULTS

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Increasing evidence suggests that regular physical activity can have considerable psychological, as well as physical, benefits in the elderly. Although factors such as exercise dosage may be implicated in exercise-induced affect responses, it has also been suggested that social and psychological factors might influence this relationship. This study examined the roles played by exercise environment (group versus alone) and self-efficacy in affective change in 80 older adults (M age = 66 yrs) over the course of three acute exercise bouts. Using latent growth curve methodology and statistically controlling for duration and intensity of exercise, we were able to demonstrate that social (group) environments resulted in statistically significant improvements in feeling state responses when contrasted with a condition in which the participants exercised alone. In addition, increases in self-efficacy were associated with more positive and less negative feeling states. Environmental factors that might influence the exercise–affect response are discussed and recommendations for subsequent exercise, efficacy, affect research made.

A growing body of evidence suggests that incorporating regular physical activity into an active lifestyle leads to considerable improvements in physical health, functional capacity, and general quality of life in older adults (Mazzeo *et al.*, 1998). Although the effects of exercise on physical health are well documented (Bouchard, Shephard and Stephens, 1994), the psychological consequences of regular activity are more equivocal. There is evidence to suggest that regular physical activity reduces depression (O'Connor, Aenchbacher and Dishman, 1993), contributes to improved cognitive function (Dustman, Emmerson and Shearer, 1994), and enhances self-efficacy and psychological well-being (McAuley and Rudolph, 1995) in older adults. However, definitive statements relative to what factors underlie these relationships have been slow in forthcoming.

Several recent studies have suggested that the nature of the exercise environment may be partially responsible for psychosocial outcomes associated with acute exercise. For example, in a recent study, Turner, Rejeski and Brawley (1997) argued that the social environment in which one is active can enhance perceptions of capabilities and affective responses. To test this proposal, they contrasted the responses of participants randomly assigned to either a socially enriched or a bland leadership style. In the former condition, participants were exposed to a leadership style typified by strong social support, high incidence of technical instruction and support, positive skill-related feedback, and a friendly communication and interpersonal style. In contrast, the bland condition was composed of

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systematic omission of support, feedback, and social interactions. The activity involved a single session of ballet for beginners and efficacy and affective responses were assessed at baseline and approximately 10 minutes following the activity. Turner *et al.* (1997) found significant increases in self-efficacy, revitalization and positive engagement across conditions but, in the case of efficacy and revitalization, these increases were significantly greater in the socially enriched condition. Thus, their results offer some support for the importance of the nature of the environment in influencing efficacy and feeling state responses.

McAuley, Mihalko and Bane (1996) contrasted a control condition, a laboratory exercise condition, and a natural environment exercise condition in an effort to determine whether environment influenced anxiety responses to acute exercise. Their findings suggested that the exercise conditions reduced anxiety, whereas the control condition (sitting quietly) had little effect on anxiety. However, the two exercise conditions did not differentially reduce anxiety. Although the authors showed little difference between conditions in ratings of perceived exertion, no attempts were made to control for duration or intensity of activity. There is some evidence to suggest that durations greater than 20 minutes are required for significant anxiety reductions (Petruzzello, Landers, Hatfield, Kubitz and Salazar, 1991). In contrast to the previous findings, Katula, McAuley, Mihalko and Bane (1998) were able to demonstrate that differing exercise environmens did influence psychosocial responses in exercise settings. In this experiment, participants exercised in a standard laboratory condition, in front of a full-length mirror in a laboratory, or in an exercise location of their choice. Analyses revealed a sex by condition interaction with females having significantly lower efficacy expectations than males in the mirror condition but not differing statistically in the other two conditions.

An important consideration with respect to the previously discussed studies is the composition of study samples. For example, whereas the McAuley *et al.* (1996) and Katula *et al.* (1998) studies focused on individuals exercising alone, participants in the Turner *et al.* (1997) study exercised in a group setting, thereby providing more opportunities for social interaction. Given the increased importance placed upon social structures and support as antecedents of positive mental health (Rook, 1990) in older adults, we would argue that exercise environments that provide opportunities for social interaction are more likely to result in enhanced affect. An additional consideration is that most studies of exercise environment effects on psychosocial function have employed college students as participants and thus, we are unable to generalize to older adults. Indeed few, if any studies, have attempted to contrast environmental influences on exercise-induced affect in older adults.

In addition to the exercise environment, a host of other influences have been hypothesized to underlie the exercise–affect relationship. For example, considerable attention has been paid to the role played by differing doses of exercise on affective responses (for an extensive review see Ekkekakis and Petruzzello, in press). Again, much of this work has focused on younger populations, often college students, and rarely has it been theoretically-based. Some of the more well-controlled studies are suggestive of a negative effect of higher intensity exercise on affect (e.g., Kennedy and Newton, 1997), although it is difficult to compare studies due to a lack of load standardization. For example, Hardy and Rejeski (1989) report positive feeling states to decrease with increasing exercise intensity and Steptoe and Bolton (1988) found higher intensities to result in increased tension and anxiety post-exercise. Conversely, one of the few studies to examine older adults compared the affective responses of young and old untrained men to maximal exercise testing but failed to find any significant change in affect (Hatfield, Goldfarb, Sforzo and Flynn, 1987). Gauvin, Rejeski, Norris and Lutes (1997) also failed to find any affect-enhancing effects due to exercise intensity in a community sample of sedentary adults. Whether the social context of the exercise environment influences exercise-induced affective responses beyond any influence of exercise dose remains to be determined.

Another approach to understanding exercise-induced affective responses has been to examine the role played by self-efficacy (Bandura, 1997; 1986). This approach has been applied to both dose–response paradigms and, more recently, examinations of environmental influences. For example, Tate, Petruzzello and Lox (1995) were unable to demonstrate that pre-exercise efficacy was related to affective responses during exercise at 70% maximal effort but in a lower intensity condition (55% maximal effort) efficacy and affect were significantly related. Although these findings are somewhat confounded by fitness levels and the generally high levels of self-efficacy of the participants prior to exercise (Tate *et al.*, 1995), they suggest that as intensity increases, any efficacy–affect relationship is attenuated. Indeed, under extreme levels of intensity, e.g., maximal exercise testing, it is possible that physiological cues become so salient that perceptions of efficacy are completely overshadowed by the physical stress.

Treasure and Newbery (1998) have reported that moderate intensity activity (45–50% of age predicted heart-rate reserve; HHR) resulted in greater feelings of revitalization and less physical exhaustion than high intensity activity (70–75% HHR) in two groups of sedentary college students. More interestingly, they found pre-exercise self-efficacy to be inversely related to feelings of in-task exhaustion for individuals in the high intensity group. These results were interpreted by Treasure and Newbery (1998) as offering some support for McAuley and Courneya's (1992) proposition that self-efficacy may be more strongly implicated in affect generation under more challenging circumstances.

With respect to the environment–efficacy–affect relationship, as noted earlier, Turner *et al.* (1997) contrasted enriched and bland exercise environments showing increases in positive affect and self-efficacy in the enriched environment. However, they were unable to demonstrate a significant relationship between efficacy at baseline or changes in efficacy with changes in feeling states. These findings fail to substantiate other work which has linked efficacy to exercise-induced feeling states (e.g., Bozoian *et al.*, 1994; McAuley and Courneya, 1992).

Thus, we have at least three potential sources of variation in exercise-induced affect; the environment, perceptions of capabilities, and exercise dosage. The extent to which the exercise environment and self-efficacy represent influences on exercise-induced affect that are independent of the exercise dose has yet to be demonstrated. Indeed, if such relationships could be documented, they would have important implications for maximizing opportunities for psychological benefits from exercise by modifying exercise environments or enhancing efficacy cognitions. This would seem to be particularly important in older adults. It is well-documented that regular physical activity can reduce morbidity and mortality (Bouchard *et al.*, 1994) but improving older adults' health-related quality of life is an increasingly important public health objective. Physical activity is clearly a behavioral modality that can accomplish such a goal, in part, by its influence on the emotional component of health-related quality of life (Rejeski, Brawley and Shumacher, 1996).

In an effort to examine the issues previously outlined, we designed a study in which older adults exercised under three differing exercise environments. Two of these conditions involved participants exercising in a social/group environment whereas in the third condition, participants exercised alone. The study had two primary purposes. First, we were interested in determining whether different exercise environments influenced affective responses independent of the many effects of exercise intensity and duration. Second, we examined the extent to which changes in exercise self-efficacy were associated with changes in affective responses to acute exercise, once again independent of exercise doseage.

METHOD

Participants

Sedentary, older (M age = 65.5 years), adults were recruited through local media advertising to participate in a 6-month randomized controlled exercise trial. Inclusion criteria for participation in the program were: (a) aged 60 to 75 years, (b) sedentary, as defined by a lack of regular involvement in exercise during the previous six months verified by exercise history and assessment of aerobic capacity by maximal graded exercise testing, (c) healthy to the degree that participation in exercise testing and an exercise program would not exacerbate any existing symptomology, (d) personal physician's clearance for participation, (e) adequate mental status, and (f) willingness to be randomly assigned to treatment condition. From an overall sample of 174 participants (49 males, 125 females) entering the trial, a subsample ($n = 80$) of individuals participated in this study.

For the larger trial participants were randomly assigned to one of two treatment conditions, an aerobic activity program (mall walking) or a stretching and toning program, based on a modification of the baseline-adaptive randomization scheme of Begg and Iglewicz (1980). This approach used medication class as the randomization class (see Table 1 for details of health status and medication use) and the process was implemented within each stratum of important baseline variables (e.g., gender and age), minimizing differences between groups. The exercise groups followed basic ACSM guidelines (1991), including adequate warm-up and cool down periods and progressive increments in exercise duration and intensity. Exercise duration began at 10–15 minutes and progressed by one minute per session to 40 minutes for 3 sessions per week for 6 months. The stretching and toning group met with the same frequency and duration as the aerobic group and were led by an experienced instructor. Further details of the exercise conditions can be found in McAuley *et al.* (1999). Preliminary analyses indicated that both groups responded similarly in terms of the outcome variables of interest and were therefore collapsed for subsequent analyses.

Measures

Demographics, physical and mental health, and physical activity history. Each participant completed an inventory providing demographic information and details of their medical history and lifestyle/exercise habits prior to participation in the physical fitness assessment. The health information obtained was used for four purposes: (1) to assess the individual's risk of cardiovascular disease; (2) to determine supervisory requirements for exercise testing and training; (3) to identify potential contraindications for participation in the study; and (4) to ascertain the physical activity histories of all subjects. Determination of the above was based on the criteria established by the American College of Sports Medicine Guidelines for Exercise Testing and Training (1991). In addition, all participants completed a measure of mental status, the Pfeiffer Mental Status Questionnaire (Pfeiffer, 1975), to screen for cognitive impairment.

Table 1 Percentages for demographic and health status variables by gender

Variable		*Men* (*n* = *17*)	*Women* (*n* = *63*)
Demographics	Marital status (%)		
	Married	88.2	52.4
	Divorced/Separated	5.9	12.7
	Single	0.0	6.3
	Widow/Widower	5.9	28.6
	Education (%)		
	10–11th grade	0.0	1.6
	high school	5.9	27.0
	1–3 years college	29.4	17.5
	College graduate	29.4	27.0
	Master's degree	23.5	22.2
	Ph.D	11.8	4.8
	Annual income (%)		
	< $5000	0.0	1.6
	$10,000–15,000	0.0	10.0
	$15,000–20,000	6.3	8.3
	$20,000–25,000	6.3	10.0
	$25,000–30,000	12.5	18.3
	$30,000–40,000	18.8	15.0
	> $40,000	56.3	36.7
	Ethnicity (%)		
	White	100.0	98.4
	Hispanic	0.0	1.6
Current medication	Cardiovascular (%)	29.4	18.0
	Antihypertensive (%)	35.3	31.1
	Neuroleptic (%)	0.0	3.3
	Antidepressant (%)	0.0	9.8
	Immunosuppresant (%)	0.0	0.0
	Estrogen replacement (%)		32.8
Disease status	CVD (%)	17.6	6.6
	Hypertension (%)	41.2	42.6
	Cerebrovascular (%)	0.0	0.0
	Arthritis (%)	11.8	26.2
	Diabetes (%)	0.0	6.6
	Cancer (%)	5.9	6.6

Self-efficacy. Self-efficacy was assessed as a function of participants' beliefs in their physical capability to successfully complete incremental 5-minute periods of walking (5 to 40 minutes) at a moderately fast pace. For each of the eight items, participants indicated their confidence to execute the behavior on a 100-point percentage scale comprised of 10-point increments, ranging from 0% (not at all confident) to 100% (highly confident). Total strength for the measure of self-efficacy was then calculated by summing the confidence ratings and dividing by the total number of items in the scale, resulting in a maximum possible efficacy score of 100. This measure is similar to those previously employed in the physical activity and aging literature (McAuley, Courneya, and Lettunich, 1991). Internal consistencies for the measure pre- and post-exercise were excellent ($\alpha > 0.95$). Change in self-efficacy was computed by subtracting the pre-exercise efficacy score from the post-exercise score.

Affect. Affective responses to the exercise stimuli were assessed by the Subjective Exercise Experiences Scale (SEES; McAuley and Courneya, 1994). The SEES is a 12-item scale assessing three general categories of subjective responses to exercise stimuli: positive well-being (PWB; e.g., great), psychological distress (PD; e.g., miserable), and fatigue (FAT; e.g., tired). For each item on the SEES, participants rate how strongly they are experiencing each feeling state along a 7-point Likert scale, ranging from 1 (not at all) to 7 (very much so). The SEES has been shown to have high internal consistency across a variety of populations, including older adults (McAuley, Shaffer, and Rudolph, 1995). The internal consistencies for the present study were acceptable for all subscales across each condition (PWB, α's > 0.85; PD, α's > 0.81; FAT, α's > 0.82).

Intensity and Duration of Exercise

Duration of exercise was determined by timing and recording each bout of activity in minutes. Intensity of activity was determined by calculation of participants' percentage of age-predicted heart rate reserve (HRR; Karvonen, Kentala and Mustala, 1957) using resting heart rate and heart rate at the end of each activity session.

Procedures

Prior to the start of the exercise trial, participants completed a questionnaire packet assessing basic demographic information, physical activity, and general medical history. All participants took part in each of the exercise conditions and completed the SEES and self-efficacy measures prior to and following each of the following three exercise conditions, which were conducted on three separate days.

Exercise conditions. We contrasted psychosocial responses to three conditions: a group condition at light exercise intensity (Group-Lt); a group condition at moderate exercise intensity (Group-Mod); and an individual exercise condition at maximal intensity (Alone-Max).[1] The *Group-Lt* consisted of one bout of the supervised standard exercise protocol as described above. In this condition, participants were free to choose their own exercise intensity within the prescribed RPE and heart rate range. At the time of data collection in this condition, all participants were in the final weeks of the 6-month exercise program. Heart rate was assessed by radial palpation prior to and immediately following the session and recorded immediately. Calculation of the percentage of age-predicted heart rate reserve indicated that the mean HRR for this condition was 0.28 (SE = 0.01) suggesting that participants were indeed working at a relatively light load. Mean duration of activity was 29.77 min (SE = 1.11).

The *Group-Mod* exercise condition was achieved by having participants complete the one-mile Rockport Walking Test (Kline *et al.*, 1987). This test was completed in the last week of the trial and participants were required to walk one mile as quickly as possible on an indoor track without over-exerting or injuring themselves. Walking performance was timed and heart rate was recorded before and after the test using radial palpation. Examination of their %HRR suggested that a moderate exercise intensity was being achieved ($M = 0.46$; SD = 0.02). Mean activity duration in this condition was 17.36 min (SE = 0.26).

[1] Although a maximal intensity group condition would make for a more elegant design, it is clearly not possible or practical to attain such a condition. Subsequent analyses in which intensity and duration are used as covariates allows us to look at the condition (environment) differences independent of dose of exercise.

Finally, the *Alone-Max* condition involved participants completing a maximal graded exercise test at the end of the trial. This test was conducted on a motor-driven treadmill employing a modified Balke protocol (ACSM, 1991). The protocol involves walking at a speed of 3 mph with increasing grade increments of 2% every 2 min. Measurements of oxygen uptake, heart rate and blood pressure were continuously monitored. Oxygen uptake (VO_2) was measured from expired air samples taken at 30 second intervals until a peak VO_2, the highest VO_2, was attained at the point of test termination due to symptom limitation and/or volitional exhaustion. Other evidence of maximal effort employed were a respiratory exchange ratio ≥ 1.0 and/or a heart rate approaching the age-predicted maximum (i.e., 220-age). Heart rate was taken during each work stage through continuous direct 12-lead electro cardiographic monitoring. Blood pressure was measured by auscultation and a sphygmomanometer. A physician and nurse monitored and supervised all aspects of the graded exercise testing. Once again, participants' mean %HRR indicated that the desired maximal intensity was being achieved ($M = 0.96$, $SE = 0.02$). Average duration of exercise for this bout was 11.42 min ($SE = 0.45$). Due to the nature of data collection (e.g., all maximal exercise tests took place after the program was concluded), the conditions were not counterbalanced.

Treatment of Missing Data and Analytical Plan

Missing data. Although our sample was composed of 80 participants, a number of these individuals had some missing data. No variable had greater than 13.8% (11 cases) of missing data. Typical approaches to the analysis of such data would employ listwise deletion procedures, using only data that were complete at all time points. This necessitates the discarding of potentially useful data and the likelihood of sampling bias if the missing data are not missing completely at random (Muthén, Kaplan and Hollis, 1987). To overcome this problem, we employed a raw maximum likelihood estimation procedure implemented in the structural equation modeling program AMOS (Arbuckle, 1997). In this procedure, the log-likelihood of the data is calculated providing reliable standard errors for analyses incorporating missing data. Thus, our analyses maximize all available data and employ all 80 participants.

Analytic plan. Our interest was in examining the differential effects of the three exercise conditions on affective change over the course of each acute bout and to determine whether self-efficacy influenced such change. Because we have repeated measures over time, we elected to employ latent growth curve methodology to compare affective responses across environmental conditions and the role played by efficacy in affect generation (Duncan and Duncan, 1995; McArdle, 1988; Meredith and Tisak, 1990). Latent growth curve methodology (LGM) has a number of advantages over repeated measures analysis of variance models. For example, in analysis of variance only factor means are of interest, whereas LGM takes into consideration both factor means and variances. Additionally, LGM allows for associations among individual difference variables thereby enabling assessment of correlates of change in a structural equation modeling fashion (Duncan and Duncan, 1995; Meredith and Tisak, 1990).

Thus, we first examined change in the three affective dimensions (positive well-being, psychological distress, and fatigue) across the three exercise conditions. Because we were primarily interested in contrasting the exercise environments, we included participants' exercise duration and intensity as covariates in these analyses thereby controlling for any differential effects of exercise dose. This model is the very simplest latent growth curve approach, examining developmental change between two time points. Given that the focus of our analyses was on change in the affective responses, and to simplify the analyses given the relatively small sample size, difference scores for the two time points (pre- and post-exercise) were constructed. The difference score is mathematically equivalent to the linear slope of the simple two-factor latent growth curve model for two time points. In this case, however, the intercept is eliminated. Following these analyses, we examined the extent to which affect change under each of the exercise conditions was influenced by changes in self-efficacy.

Model Testing

In order to determine whether the exercise environments resulted in differential changes in affect after controlling for exercise intensity and duration, it was necessary to conduct and compare several competing models.[2] Initially, a totally unconstrained model (i.e., freely estimated) was calculated as an omnibus test of environmental effects on affect. This was followed by a model (for each affective dimension) in which parameter estimates for all three exercise conditions were constrained to be equal. This was then statistically compared to the omnibus test. For illustrative purposes, consider positive well-being. If the χ^2 difference test is significant, this suggests that there is a significant difference among the exercise conditions in well-being. In order to determine the nature of this difference, it is then necessary to constrain parameter estimates for pairs of conditions to be equal, allowing a statistical comparison of these constrained models to the unconstrained model. Thus, we would constrain, for example, the parameter estimate for change in positive well-being in the Alone-Max condition with the Group-Mod condition, and then with the Group-Lt condition. This procedure is then conducted for each of the affective measures (dimensions). In this manner, it is then possible to determine exactly which environmental exercise conditions elicit differential responses.

To test the association of self-efficacy with affect change at each exercise condition, we first conducted a model whereby self-efficacy change is hypothesized to influence the affective responses to the respective exercise condition, after statistically controlling for intensity and duration of activity. Following standard modeling procedures for correlated observations, individual error terms for each affective change score across each condition were allowed to covary. This model was then compared to a fully saturated model and a χ^2 difference test conducted. A nonsignificant χ^2 is indicative of a good fit of the model to the data. Additionally, we calculated two other fit indices considered particularly appropriate for smaller samples, the Non-Normed Fit Index (NNFI), and the Comparative Fit Index (CFI), to further test the fit of the model to the data. Values in excess of 0.90 are deemed a good fit.

RESULTS

Preliminary Analyses

Biometric data, exercise history, and medical status for the two treatment groups at baseline are detailed in Tables 1 and 2. As can be seen, the sample is predominantly Caucasian,

[2] For further exposition of model testing using latent growth curve methodology the reader is directed to Duncan, Duncan, Strycker, Li and Alpert (1999).

Table 2 Means and standard deviations for biometric data at baseline by gender

Variable	*Men (n = 17)*		*Women (n = 63)*	
	M	*SD*	*M*	*SD*
Age	66.58	(4.54)	67.50	(5.88)
Weight	92.10	(11.18)	76.32	(14.84)
Fat percentage	0.30	(0.05)	0.41	(0.04)
VO_2 peak (Ml/kg/min)[a]	23.90	(3.77)	19.78	(3.89)
Respiratory exchange rate (RER)[a]	1.04	(0.09)	1.05	(0.10)
Systolic blood pressure	140.12	(18.32)	142.73	(21.92)
Diastolic blood pressure	80.59	(9.51)	82.19	(10.42)

[a]Men $n = 15$; Women $n = 59$.

relatively well-educated, overweight, and of low cardiovascular fitness. Participants in the aerobic and stretching/toning conditions did not differ significantly at baseline on any of the demographic or health status variables (all $ps > 0.10$). Table 3 shows mean (SE) values for all affective and self-efficacy change measures under each exercise condition.

Bearing in mind that participants were engaged in two differing physical activity programs (stretching/toning and walking) at time of assessment, preliminary analyses (t-tests) were conducted to determine whether differences existed on affective and efficacy responses by exercise group across exercise condition. Of all of the tests conducted, only one was significant with the walking group reporting higher fatigue following the light intensity condition. Given these findings, it was deemed acceptable to collapse data across the two exercise groups.

Exercise Condition Effects on Affect

Positive well-being. The initial model constraining all three conditions to be equal, when compared to the omnibus unconstrained model was significant, $\chi^2(2) = 6.77$, $p < 0.05$, suggesting that significant differences in positive well-being existed across conditions. Subsequent model comparisons revealed significant effects when comparing Alone-Max with Group-Lt ($\chi^2(1) = 5.24$, $p < 0.05$) and Group-Mod conditions ($\chi^2(1) = 4.67$, $p < 0.05$). The two group conditions did not differ statistically, although examination of the parameter estimates (see Table 3) indicate an interesting pattern. In effect, there was a significant increase in positive well-being in the case of the Group-Lt exercise condition, a small, non-significant decrease in the Group-Mod condition, and a significant decrease in well-being in the Alone-Max condition. These findings suggest that the group environment appears to

Table 3 Means (Standard Errors) for efficacy and affect change measures within differing exercise conditions across time

Variable	*Group-Light*	*Group-Moderate*	*Alone-Maximal*
Efficacy	2.54 (1.44)	5.52 (1.70)*	0.27 (1.63)
Fatigue	−0.05 (0.50)	3.88 (0.60)*	6.10 (0.70)*
Positive well-being	1.20 (0.41)*	−0.31 (0.45)	−1.53 (0.45)*
Psychological distress	−0.83 (0.44)	0.53 (0.39)	1.32 (0.39)*

* t-value > 1.96; p < 0.05.

have a more beneficial effect on well-being in older adults than the alone condition, even when intensity and duration of activity are controlled.

Psychological distress. As with positive well-being, the initial model constraining all three conditions to be equal, when compared to the omnibus unconstrained model was significant, $\chi^2(2) = 7.81$, $p < 0.05$, suggesting that significant differences across environments existed for psychological distress. Subsequent model comparisons revealed a significant difference only for the comparison of the Alone-Max and the Group-Mod conditions ($\chi^2(1) = 7.58$, $p < 0.01$) with the other two comparisons approaching significance ($p < 0.10$). Parameter estimates (see Table 3) indicated that there was a modest and marginally significant decrease in psychological distress following exercise in the Group-Lt condition and a non-significant increase in the Group-Mod condition. In the case of the Alone-Max condition, a significant increase in psychological distress was demonstrated.

Fatigue. Again, the initial model constraining all three conditions to be equal, when compared to the omnibus unconstrained model was significant $\chi^2(2) = 12.45$, $p < 0.01$, suggesting that significant differences in fatigue existed across exercise conditions. Subsequent model comparisons revealed significant effects of condition on fatigue when comparing Alone-Max with Group-Mod ($\chi^2(1) = 7.71$, $p < 0.01$) and Group-Lt conditions ($\chi^2(1) = 11.49$, $p < 0.01$). However, there was no significant difference in perceived fatigue between the two group conditions after controlling for intensity and duration. Examination of the parameter estimates (see Table 3) show no discernible change in fatigue following the Group-Lt exercise bout. This in contrast with a clear condition effect of a linear nature on fatigue for both the Group-Mod and the Alone-Max conditions. In both cases, substantial increases in perceived fatigue are reported.

Self-Efficacy Influence on Affective Change

In this set of analyses, structural models were conducted examining the independent influence of self-efficacy on affective change across conditions while controlling for intensity and duration of activity. Self-efficacy change was significantly related to changes in positive well-being, psychological distress, and fatigue but in a manner that differed across the three environments. In the Group-Lt condition, a greater increase in self-efficacy was associated with enhanced positive well-being ($\beta = 0.27$, $p < 0.05$) and less psychological distress ($\beta = -0.23$, $p < 0.05$). In the Alone-Max condition, once again, a greater increase in self-efficacy was associated with improved positive well-being ($\beta = 0.40$, $p < 0.01$) and less fatigue, ($\beta = 0.30$, $p < 0.05$). Changes in efficacy were unrelated to changes in affect in the Group-Mod condition. Examination of the parameter estimates for changes in efficacy and affect (see Table 3) indicated considerably less variability in efficacy responses in this condition than in the other two conditions suggesting that although there was greater change, the change may have been more uniform. Additionally, there was less change in the affective responses in this condition than the other two conditions, with the exception of fatigue. In combination, change in self-efficacy and the intensity and duration of exercise accounted for 4–22%, 2–17%, and 9–14% of the variation in changes in positive well-being, psychological distress, and feelings of fatigue, respectively. Clearly, these variables account for only a modest portion of the variation in affective change brought about by exercise across various environments and this was reflected in fit indices that suggested the model provided a relatively poor fit to the data, $\chi^2(112)$, $= 146.94$, $p < 0.01$, NNFI $= 0.80$, CFI $= 0.84$.

DISCUSSION

Population statistics predict that by the year 2030, there will be 70 million adults aged 65 and older living in the United States. Such statistics place an important priority on improving not just the quantity, but also the quality, of life. Although there is evidence to suggest that regular physical activity is related to a number of aspects of psychological function in older adults (Dustman *et al.*, 1994; McAuley and Rudolph, 1995; O'Connor *et al.*, 1993), little is known as to what factors underlie any change brought about by activity. The present study was designed to examine how acute exercise bouts under differing environmental conditions influenced affective responses and the extent to which perceptions of personal efficacy relative to exercise mediated any effects of exercise on affect.

Our results suggest that the determinants of psychosocial responses to exercise are not determined exclusively by physiological factors (McAuley, 1994; Turner *et al.*, 1997). When controlling for the characteristics of the exercise dose (intensity and duration of activity), we were able to demonstrate a pattern of results that suggests older adults' affective responses to physical activity may be enhanced under group or social environments rather than those environments that necessitate the individual exercising alone. We are conscious of the limitations of the current design which precludes any comments relative to the effects of contrasting light and moderate activity in individual exercise conditions with those conditions tested in the present study.

The above findings are in keeping with Turner *et al.*'s (1997) findings with younger individuals reporting more positive responses to a socially enriched condition than a bland exercise condition. Examination of mean changes in affect across the three conditions would appear to suggest a dose–response relationship between intensity and affect. That is, as the intensity component increases, positive well-being is reduced while fatigue and psychological distress are increased. Greater benefits for older adults would therefore be seen to take place at low intensity levels. However, adjusting for any covariation of affective change with intensity and duration, leads to the conclusion that the social composition of the exercise environment may influence affective responses. These findings corroborate other reports that more positive feeling states are reported in naturalistic exercise conditions than laboratory conditions (Gauvin and Rejeski, 1993) and are influenced by the exercise instructor (McAuley and Jacobson, 1991). In the present study, both of the group environment conditions offered multiple opportunities for feedback and social interaction, the components of the Turner *et al.* (1997) intervention implicated with influencing feeling state responses. Evidence from other studies also suggests that the natural environment is more conducive to anxiety reduction than is the laboratory (McAuley *et al.*, 1996). However, we acknowledge that the nature of our Group-Mod condition (i.e., walking one mile as fast as possible) did perhaps offer less opportunity for social interaction than the Group-Lt condition.

There are several possible suggestions for what aspects of the group environment might be operating to influence exercise-related feeling states. For example, organized group exercise sessions offer an ideal opportunity for social support influences to develop. There is certainly evidence that elements of social support influence exercise participation (Dishman and Sallis, 1994; Duncan and McAuley, 1993). It has also been argued that optimizing the supportive provisions available in the individual's social network enhances a sense of belonging, self-worth and reliable interdependence (Gottlieb, 1985). Such characteristics are also likely to be associated with positive affective responses. In particular, the extent to which enhanced emotional support (e.g., through "buddy groups" etc.) influences affective responses may be of particular interest. Given that a number of researchers have suggested that improved feeling states resulting from physical activity may be an important determinant of exercise adherence (e.g., Rejeski, 1994), subsequent empirical examination of these relationships is warranted.

Other evidence in the exercise and health psychology literature suggests that social support influences on exercise behavior are mediated by self-efficacy (Duncan and McAuley, 1993; Duncan, McAuley, Stoolmiller and Duncan, 1993). Alternatively, improvements in efficacy may come about as a function of social comparison with efficacy improvements being based on performance relative to exercising peers. Such improvements in efficacy have been proposed to be an important factor underlying affective change brought about by exercise (McAuley, 1994). Our results offer some support for such a proposition. However, the relationship appears fairly complex. Under the regular exercise session condition (Group-Lt) and the maximal exercise testing condition (Alone-Max), increases in self-efficacy over the course of the exercise session were associated with enhanced positive well-being, less psychological distress (Group-Lt), and less fatigue (Alone-Max). Why there was no relationship between efficacy and affect under the Group-Mod (walking a mile as fast as possible) is not entirely clear. As noted earlier, it may be that the social component of this condition was reduced due to the nature of the task (i.e., walking for time). Examination of parameter estimates, however, suggest that the least amount of affective change was being experienced in the Group-Mod condition but that this condition resulted in the greatest change in self-efficacy.

McAuley and Courneya (1992) have suggested that the efficacy–affect relationship may get stronger as the exercise becomes more challenging. Findings from the present study offer rather mixed support for this proposition demonstrating an efficacy–affect relationship at the lower and upper ends of the exercise challenge spectrum. However, it must be remembered that our analyses statistically control for elements of the physiological stress being placed on the body. Typically, other efforts at examining this relationship have been conducted on a single sample exercising at a similar intensity (Mihalko, McAuley and Bane, 1996), compared independent samples exercising at differing intensities (Treasure and Newbery, 1998), or single samples exercising at differing intensities in the same environment (Tate *et al.*, 1995). None of these studies have, in effect, offered an adequate test of McAuley and Courneya's (1992) hypothesis. Although one would expect that at high intensities, physiological cues would override cognitive processing, our findings suggest that not to be the case. Clearly, efficacy–affect relationships in the exercise domain are quite complex and warrant careful further examination.

As discussed above, the exercise environment and individual efficacy expectation appear to be implicated in the generation of exercise-induced affect in older adults. Given the findings that the social/group nature of the environment may present more favorable circumstances for positive affective responses to occur, it may also be reasonable to begin to examine the extent to which group or collective efficacy plays a role in changing affect. Bandura (1997) has suggested that beliefs relative to what the group is capable of may be particularly important in sustaining difficult behaviors which are initially influenced by individual belief structures. Certainly evidence in the group dynamics literature would suggest that accomplishment of social objectives through group processes are likely to lead to greater participant satisfaction and enjoyment. A socially supportive group environment would be theorized to influence group behavior and affect through its impact on collective self-efficacy. The extent to which group and individual processes independently influence affective responses to acute exercise remains to be determined.

These findings shed new light on the exercise environment, affect, and self-efficacy relationship but specific limitations should be addressed. Although we were interested in comparing exercise environments and their differential effects on affect, we are acutely aware of the fact that our exercise conditions each consisted of different intensities and durations. In an ideal design, we would have contrasted group and individual settings that were matched on these exercise components. However, this is clearly difficult to attain, especially a group setting with participants all exercising at maximal intensity. We submit that we have minimized this limitation by effectively controlling for any covariation between the intensity and duration components and affective change. Indeed, there are very few studies at all that employed maximal exercise when examining psychosocial responses and most certainly none that have employed a sample of this size across three separate conditions.

A second limitation concerns the time course of affect assessment. One of the more recent advances in the exercise–affect research of late has been the examination of exercise effects on in-task affective responses (McAuley and Courneya, 1992; Tate *et al.*, 1995; Turner *et al.*, 1997). Such an approach allows a more comprehensive examination of the process of feeling state changes brought about by physical activity. Due to the nature of the exercise conditions employed in the present study, it was simply not possible to collect in-task affective responses. Given the interesting pattern of relationships between feeling states and self-efficacy across environments, design of subsequent experiments should pay particular attention to the inclusion of some in-task affective assessments.

Although the results of this study offer some interesting new data pertinent to the relationships among exercise-induced affect, exercise environment, and self-efficacy in older adults, it is necessary to replicate such findings under differing conditions and with other samples. As self-efficacy has been quite consistently associated with exercise-induced feeling states, studies are now called for that systematically attempt to manipulate self-efficacy in the exercise environment in an effort to examine further this construct's influence on affect (McAuley, Talbot and Martinez, 1998). In particular, the role played by exercise leaders, other group members, and the structure of exercise environments in influencing self-efficacy and affect are worthy of further examination.

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